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DEVELOPMENT OF A PROTOTYPE FLAT WINDING MACHINE FOR
WINDING AIR DEPLOYED FIBEROPTIC CABLE(U) MACHINE DESIGN
ENGINEERS INC KENT WA V D GOODWIN 11 DEC 84

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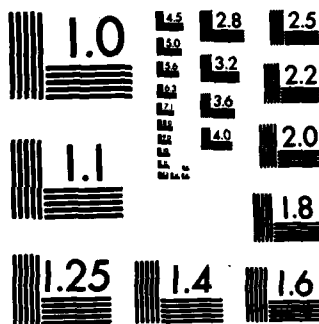
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Defense
Advanced Research
Projects Agency

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**DEVELOPMENT OF A PROTOTYPE FLAT WINDING MACHINE
FOR WINDING AIR DEPLOYED FIBEROPTIC CABLE**

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4 December, 1984

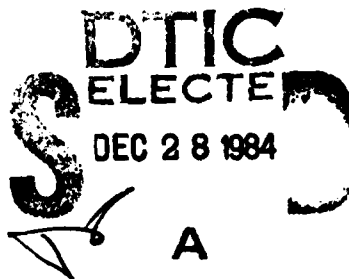
Interim Report For November, 1984
Contract No. N00014-84-C-0769

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Prepared For:
Office of Naval Research
Department of the Navy
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Arlington, Virginia 22217



Defense Advanced Research Projects Agency
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84 12 14 023

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
AD-A149038		
4. TITLE (and Subtitle) DEVELOPMENT OF A FLATWINDING MACHINE FOR AIR DEPLOYED FIBER OPTIC CABLE		5. TYPE OF REPORT & PERIOD COVERED Interim Report November 1984
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Vern D. Goodwin		8. CONTRACT OR GRANT NUMBER(s) N00014-84-C-0769
9. PERFORMING ORGANIZATION NAME AND ADDRESS Machine Design Engineers, Inc. 19226 66th Ave. So. #L-109 Kent, WA 98032		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Office of Naval Research, Department of the Navy 800 N. Quincy Street Arlington, Virginia 22209		12. REPORT DATE 11 December 1984
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Defense Advanced Research Projects Agency 1400 Wilson Boulevard Arlington, Virginia 22217		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release, Distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Approved for public release, Distribution unlimited		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Winding, Flat Winding, Pancake Winding, High Speed Payout, Cable Payout Fiber Optic Cable, Fiber Optic Cable Winding, Cable Winding		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This interim report covers the progress for the first month of efforts to develop a machine for flat winding fiber optic cable intended for air deployment. This new winding technology involves winding the cable into a spool shape by winding successive flat layers (pancake style) which are placed on top of one another. This report includes a description of the "kick off" meeting held at the Machine Design Engineers offices, technical objectives of the project as they are understood at this time, and a schedule of milestones to be accomplished during the course of the project.		

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Procuring Contracting Officer Office of Naval Research Department of the Navy 800 N. Quincy Street Arlington, Virginia 22217	1

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1.0 INTRODUCTION

Glass fibers are being used as media for acoustic sensors based on optical phase change detection. Deployment of these fibers requires that they be first wound into a small package of a configuration suitable for payout from an aircraft or similar conveyance. As a result, Machine Design Engineers was awarded contract N00014-84-C-0769 by the office of Naval Research to prove the feasibility of a concept of a machine to flat wind fiber optic cable into packs suitable for air deployment. This new technique involves winding successive layers of the cable into flat wound coils (pancake fashion) and placing the layers on top of one another until the desired pack length is realized. Using this pack configuration, payout would occur with the pack stationary and the cable being pulled from one end. The pack would not get smaller in diameter as the payout progresses, the length of the pack would get smaller. The work is to include evaluation of the concept as to the machine's capability to wind the various types of cable into flat layers, transition from one layer to the next, provide a pre-twist in the cable, apply glue and matrix compounds, interface with cannisters and adapt to computer control. A hand operated prototype will be designed and built for testing to identify the problems and to prove feasibility.

This interim report summarizes the progress of the project to

date. The "kick off" meeting involving Machine Design Engineers, Hughes Aircraft, and Navy personell is described. A summary of the technical objectives of the project as understood through discussions with Navy personel since the award of the contract is included. A schedule showing the milestones to be accomplished during the performance of the contract is provided.

1.0 "KICK OFF" MEETING

A meeting was held at the facilities of Machine Design Engineers, Inc. on October 25, 1984. The purpose of the meeting was to coordinate the thinking of the people involved in the project. Required parameters and desired results were discussed.

The following people were in attendance at the meeting: Richard Freeman, Arthur Nakagawa, and Alan Nobunaga of the Naval Ocean Systems Center; Dave Fox and Steve Anderson of the Hughes Aircraft Company; Jack Winsor, Dennis Martin, and Vern Goodwin of Machine Design Engineers Company.

Richard Freeman is the liaison for day to day technical communication between Machine Design Engineers and the Navy.

Dave Fox along with R. A. Eisentraut of the Hughes Aircraft Company, has been retained by Machine Design Engineers as a consultant to assist in the performance of this contract.

During the meeting, Richard Freeman presented various samples of fiber optic cable which the Navy is presently using or planning to use in tests of rapid payout. He indicated the range of diameters of the cable expected to be wound into a flat wound pack configuration. The dimensional range of the final wound pack as desired by the Navy for use in their testing was pointed out. Other factors, including pretwist, maximum cable length, cannister configurations, adhesives, cable stiffness, cable tension or compression in the pack, attenuation of the signal in the wound pack, payout velocity, stepback at the layer interface, and cable creep in the pack were discussed.

3.0 TECHNICAL DISCUSSION

3.1 Objectives

The objective of this study is to assess the feasibility of a machine concept for flat coil winding fiber optic cable, design a hand operated prototype of the machine, then test and evaluate the operation of the machine. The test and evaluation

of the machine is to include identifying problem areas and possible design improvements for the next generation machine. A final report will be prepared summarizing the results of the project and giving prospects for the continuation of the concept.

3.2 Parameters

The following parameters have been established during discussions with Navy personell and are being used as a guide in determining the characteristics of the prototype winding machine.

Cable diameter range: 1 mm - 3 mm (.040 in. - .120 in.)

Cable stiffness can vary between quite stiff to very limp.

Flat wound coil finished inside diameter range: 150 mm - 300 mm
(6 in. - 12 in.)

Flat wound coil finished outside diameter range: 610 mm - 910 mm
(24 in. - 36 in.)

Maximum cable length (between repeaters): 50 Km (31 miles)

Approximately 400 flatwound coil layers per pack maximum.

Cannister support on the inside and outside of the pack is acceptable.

Means to put a pretwist into the cable as it is being wound is required.

Means to put a tension or compression load into the cable as it is being wound is required.

Machine preferably will be capable of winding a complete layer without adhesive being applied. This will allow the adhesive selection to be less critical. Adhesive may also be applied as the winding progresses, if this method is found to be more advantageous.

It is desirable that the machine be capable of controlling the point where the cable spirals in each layer pass over the spirals on adjoining layers. This will allow the cross over point to be varied from layer to layer hopefully eliminating the possible buildup of a non level condition at the winding surface. This non level condition could likely be caused by the cable falling into the groove in the layer underneath in the same place on the diameter for several layers.

It is anticipated that an eventual production machine will

require computer control. This degree of sophistication is beyond the scope of this Phase I project, however, eventual computerization should be considered and planned for.

3.3 Approach

Preliminary investigation and calculation indicate that a prototype machine capable of winding all of the sample fiber optic cables would be extremely difficult if not impossible to design. There are large differences in size, bending strength, and torsional strength in the cables. This results in quite different forces being present in the winding process. While the mechanisms of winding these different cables is expected to be similiar, the size, strength and sensitivity of the controlling devices will necessarily be different. The adhesives used for holding the pack configuration will also likely be different for the various cables. Therefore it has been decided that the prototype machine will concentrate on one particular cable with attention being made in the design to allow modification of the machine for winding other cables. This has resulted in a concept of a machine with the following capabilities.

Capable of winding the 1.5 mm (.060 in.) diameter S-glass wound fiberoptic cable. Design will be so that minimum

modification is necessary for winding other cables. It is anticipated that the chosen cable is going to be one of the most difficult to wind due to its stiffness.

Capable of winding a cable pack which is 510 mm (20 in.) inside diameter and 660 mm (22 in.) outside diameter and up to 150 mm (6 in.) long. A pack of this size will interface with the NOSC payout machine when fitted with the proper mounting arrangements. A pack of this size will give a total length capacity of approximately 2800 m. (1.7 miles) which should be sufficient for payout testing. Four layers will require 110 m. (360 ft.) of cable. Design will be such that minimum modification is necessary for winding of a pack with a 300 mm (12 in.) inside diameter and 910 mm (36 in.) outside diameter and a 150 mm (6 in.) length.

Capable of winding a pack which is self supporting after the adhesive is set. A mounting mandrel can be added as desired after the winding is complete. Machine will provide containment for the outside diameter and inside diameter of the pack while the adhesive is setting.

Capable of precisely placing the cable onto the pack in the proper position for winding and of providing an adjustable tension or compression load on the cable as winding is taking place.

Capable of holding the top cable layer (the one being wound) in position on the pack without dependance on the adhesive. It is assumed that the layer below the layer being wound is self supporting due to the adhesive. This will allow winding of the complete layer prior to applying the adhesive or winding with adhesive if so desired.

Capable of applying a pretwist to the cable as it is being wound. Amount of pretwist will be adjustable from 0 to 540 degrees of twist per one rotation of the cable pack.

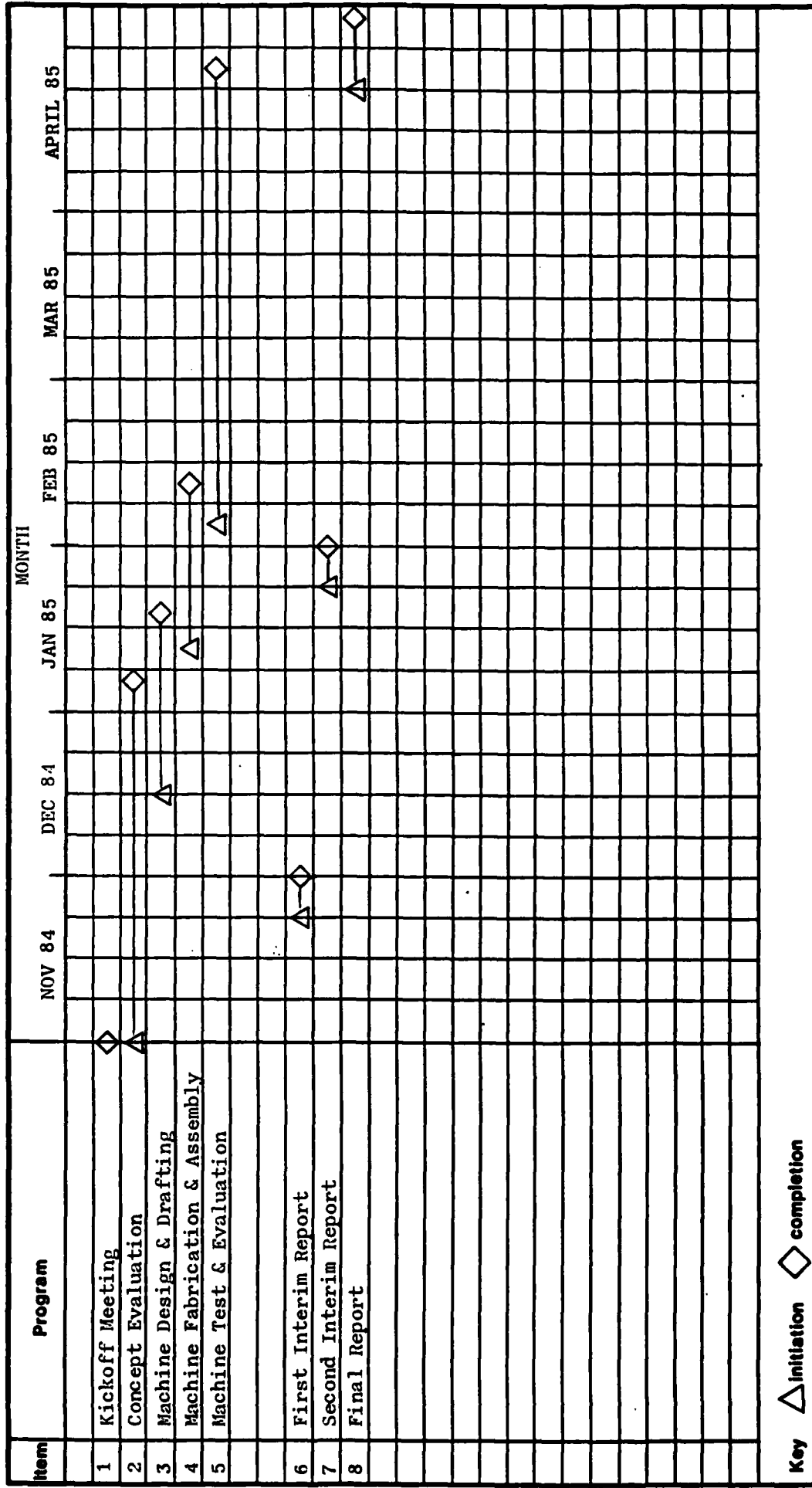
3.4 Government furnished equipment

It will be necessary for the government to supply Machine Design Engineers, Inc. with 300 meters of the 1.5 mm (.06 in.) S-glass wound fiber optic cable on or before February 1, 1985 so that testing may start as scheduled.

SCHEDULE

FLAT COIL WINDING MACHINE PROGRAM

PHASE I



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